

Amendments to the Specification:

Please replace the paragraph bridging pages 1 and 2 with the following paragraph:

The present application is a continuation of prior U.S. patent application Serial No. 09/140,988, filed on August 27, 1998, now U.S. Pat. No. 6,262,706, which is, in turn, a continuation-in-part of U.S.S.N. 08/504,896, filed July 20, 1995, now U.S. Pat. No. 6,124,851, and is a continuation-in-part of U.S.S.N. 08/983,404, filed July 19, 1997~~1996~~, and is a continuation-in-part of U.S.S.N. 08/935,800, filed September 23, 1997, the entire disclosures of which are hereby incorporated by reference herein. The present application also claims priority to U.S.S.N. 09/140, 988, filed August 27, 1998, U.S.S.N. 08/504,896, filed July 20, 1995, U.S.S.N. 08/983,404, filed July 19, 1997~~1996~~, U.S.S.N. 08/935,800, filed September 23, 1997, now U.S. Pat. No. 6,120,588, which is a continuation-in-part of PCT/US96/13469, filed August 20, 1996, and a continuation-in-part of PCT/US96/12000 filed July 19, 1996, U.S.S.N. 60/057,133, filed August 28, 1997, U.S.S.N. 60/057,716, filed August 28, 1997, U.S.S.N. 60/057,799, filed August 28, 1997, U.S.S.N. 60/057,163, filed August 28, 1997, U.S.S.N. 60/057,122, filed August 28, 1997, U.S.S.N. 60/057,798, filed August 28, 1997, U.S.S.N. 60/057,118, filed August 28, 1997, U.S.S.N. 60/059,543, filed September 19, 1997, U.S.S.N. 60/059,358, filed September 19, 1997, U.S.S.N. 60/065,630, filed November 18, 1997, U.S.S.N. 60/065,605, filed November 18, 1997, U.S.S.N. 60/065,529~~629~~, filed November 18, 1997, U.S.S.N. 60/066,147, filed November 19, 1997, U.S.S.N. 60/066,245, filed November 20, 1997, U.S.S.N. 60/066,246, filed November 20, 1997, U.S.S.N. 60/066,115, filed November 21, 1997, U.S.S.N. 60/066,334, filed November 21, 1997, U.S.S.N. 60/066,418, filed November 24, 1997, U.S.S.N. 60/071,371, filed January 15, 1998, U.S.S.N. 60/070,940, filed January 9, 1998, U.S.S.N. 60/072,390, filed January 9, 1998, U.S.S.N. 60/070,939, filed January 9, 1998, U.S.S.N. 60/070,935, filed January 9, 1998, U.S.S.N. 60/074,454, filed February 12, 1998, U.S.S.N. 60/076,955, filed March 5, 1998, U.S.S.N. 60/076,959, filed March 5, 1998, U.S.S.N. 60/076,957, filed March 5, 1998, U.S.S.N. 60/076,956, filed March 5, 1998, U.S.S.N. 60/076,978, filed March 5, 1998, U.S.S.N. 60/078,363, filed March 18, 1998, U.S.S.N. 60/081,374, filed April 10, 1998, U.S.S.N. 60/081,362, filed April 10, 1998, U.S.S.N. 60/083,252, filed April 27, 1998, U.S.S.N. 60/085,096, filed May 12, 1998, U.S.S.N. 60/090,223, filed June 22, 1998, U.S.S.N. 60/090,222, filed June 22, 1998, U.S.S.N. 60/090,232, filed June 22, 1998, U.S.S.N. 60/092,046, filed July 8, 1998, U.S.S.N. 60/092,050, filed July 8, 1998, U.S.S.N. 60/092,742, filed July 14, 1998, and U.S.S.N. 60/093,689, filed July 22, 1998, U.S.S.N. 60/022,222, filed July 19, 1996, U.S.S.N. 60/035,622, filed September 24, 1996, international application number PCT/US96/12000 filed July 19, 1996, and international application number PCT/US96/13469, filed August 20, 1996, the entire disclosures of which are hereby incorporated by reference herein.

Please replace the paragraph bridging pages 13 and 14 with the following paragraph:

In another preferred embodiment, shown in Figure 7, a single capsule acts as a retroreflector, much as a glass bead does. Only light ~~tha~~that enters the incident side 44 at a vertical displacement at a distance from the center greater than a critical distance y will strike the totally internal reflecting (TIR) side 46 at an angle great enough to be totally internally reflected. This light strikes the TIR side near its center. Thus, on the incident side 44, the retroreflective effect occurs away from the center axis. On the TIR side 46, however, most retroreflective action occurs at the vertical center.

Please replace the first paragraph on page 16, lines 1-10 with the following paragraph:

Upon application of a DC field by the two electrodes 53, the luminescent particles 50 migrate to the viewing face of the display 48 and are excited to emit light, resulting in a bright state. Upon application of an electric field of the opposite polarity, the luminescent particles 50 migrate to the back face of the display 48, and the light-blocking particles 52 block the light being emitted from the luminescent particles 50 from the viewing face of the display, resulting in a dark state. The luminescent particles may be photoluminescent or electroluminescent. Photoluminescent particles may be stimulated by continuous ultraviolet, or other, radiation from the front of the display, or the illumination source may be behind the display. In the latter case, the dye or second species of particle allows ultraviolet radiation to pass through the display.

Please replace the paragraph on page 17, lines 15-24 with the following paragraph:

In other embodiments of the invention, it is preferred that the capsules of the electrophoretic display have a non-spherical shape. There are some optical losses associated with encapsulated electrophoretic displays compared to unencapsulated displays due to absorption or scattering by the capsule materials, and absorption or scattering of the binder. Many of these losses result from spherical cavities. It is, therefore, advantageous to provide a non-spherical microcapsule, specifically a close ~~paked~~packed array of non-spherical cavities. It is desirable that the top of the microcapsule have a flat surface that is co-planar with the viewing electrode and vertical, or nearly vertical, walls. The capsule may be a slightly flattened sphere, a heavily flattened sphere, essentially cylindrical in shape, or a multi-faceted polyhedron, for example.

Please replace the paragraph on page 18, lines 14-22 with the following paragraph:

Non-spherical microcapsules can be formed during the encapsulation phase, by, for example, using a non-uniform shear field or a compressive pressure. Such non-spherical capsules can also be formed during the processing of the display when the binder is drying or curing. In such a system, as the binder shrinks, it pulls capsules close to one another and pulls the capsules down toward the substrate on which they have been coated. For example, an aqueous evaporative binder, such as a waterbourne acrylic, urethane, or poly (vinyl alcohol/vinyl alcohol), for example, tends to exhibit such shrinking properties. Any other evaporative binder, emulsion, or solution would also be suitable. The solvent need not be water, but can be an organic liquid or a combination of liquids.

Please replace the paragraph bridging pages 22 and 23 with the following paragraph:

Useful neat pigments include, but are not limited to, PbCrO₄, Cyan blue GT 55-3295 (American Cyanamid Company, Wayne, NJ), Cibacron Black BG (Ciba Company, Inc., Newport, DE), Cibacron Turquoise Blue G (Ciba), Cibalon Black BGL (Ciba), Orasol Black BRG (Ciba), Orasol Black RBL (Ciba), Acetamine Blac, CBS (E. I. du Pont de Nemours and Company, Inc., Wilmington, DE, herein after "du Pont"), Crocein Scarlet N Ex (du Pont) (27290), Fiber Black VF (~~du Pont~~du Pont) (30235), Luxol Fast Black L (~~du Pont~~du Pont) (Solv. Black 17), Nirosine Base No. 424 (~~du Pont~~du Pont) (50415 B), Oil Black BG (~~du Pont~~du Pont) (Solv. Black 16), Rotalin Black RM (~~du Pont~~du Pont), Sevron Brilliant Red 3 B (~~du Pont~~du Pont); Basic Black DSC (Dye Specialties, Inc.), Hectolene Black (Dye Specialties, Inc.), Azosol Brilliant Blue B (GAF, Dyestuff and Chemical Division, Wayne, NJ) (Solv. Blue 9), Azosol Brilliant Green BA (GAF) (Solv. Green 2), Azosol Fast Brilliant Red B (GAF), Azosol Fast Orange RA Conc. (GAF) (Solv. Orange 20), Azosol Fast Yellow GRA Conc. (GAF) (13900 A), Basic Black KMPA (GAF), Benzofix Black CW-CF (GAF) (35435), Cellitazol BNFV Ex Soluble CF (GAF) (Disp. Black 9), Celliton Fast Blue AF Ex Conc (GAF) (Disp. Blue 9), Cyper Black IA (GAF) (Basic Blk. 3), Diamine Black CAP Ex Conc (GAF) (30235), Diamond Black EAN Hi Con. CF (GAF) (15710), Diamond Black PBBA Ex (GAF) (16505); Direct Deep Black EA Ex CF (GAF) (30235), Hansa Yellow G (GAF) (11680); Indanthrene Black BBK Powd. (GAF) (59850), Indocarbon CLGS Conc. CF (GAF) (53295), Katigen Deep Black NND Hi Conc. CF (GAF) (15711), Rapidogen Black 3 G (GAF) (Azoic Blk. 4); Sulphone Cyanine Black BA-CF (GAF) (26370), Zambezi Black VD Ex Conc. (GAF) (30015); Rubanox Red CP-1495 (The Sherwin-Williams Company, Cleveland, OH) (15630); Raven 11 (Columbian Carbon Company, Atlanta, GA), (carbon black aggregates with a particle size of about 25 μ m), Statex B-12 (Columbian Carbon Co.) (a furnace black of 33 μ m average particle size), and chrome green.

Please replace the paragraph on page 24, lines 9-24 with the following paragraph:

Useful polymers for the particles include, but are not limited to: polystyrene, polyethylene, polypropylene, phenolic resins, ~~Du Pont~~ du Pont Elvax resins (ethylene-vinyl acetate copolymers), polyesters, polyacrylates, polymethacrylates, ethylene acrylic acid or methacrylic acid copolymers (Nucrel Resins - ~~du Pont~~ DuPont, Primacor Resins- Dow Chemical), acrylic copolymers and terpolymers (Elvacite Resins, ~~du Pont~~ DuPont) and PMMA. Useful materials for homopolymer / pigment phase separation in high shear melt include, but are not limited to, polyethylene, polypropylene, polymethylmethacrylate, polyisobutylmethacrylate, polystyrene, polybutadiene, polyisoprene, polyisobutylene, polylauryl methacrylate, polystearyl methacrylate, polyisobornyl methacrylate, poly-t-butyl methacrylate, polyethyl methacrylate, polymethyl acrylate, polyethyl acrylate, polyacrylonitrile, and copolymers of two or more of these materials. Some useful pigment/polymer complexes that are commercially available include, but are not limited to, Process Magenta PM 1776 (Magruder Color Company, Inc., Elizabeth, NJ), Methyl Violet PMA VM6223 (Magruder Color Company, Inc., Elizabeth, NJ), and Naphthol FGR RF6257 (Magruder Color Company, Inc., Elizabeth, NJ).

Please replace the paragraph bridging pages 25 and 26 with the following paragraph:

Another manufacturing technique for particles drawn from the liquid toner field is to add the polymer, pigment, and suspending fluid to a media mill. The mill is started and simultaneously heated to temperature at which the polymer swells substantially with the solvent. This temperature is typically near 100°C. In this state, the pigment is easily encapsulated into the swollen polymer. After a suitable time, typically a few hours, the mill is gradually cooled back to ambient temperature while stirring. The milling may be continued for some time to achieve a small enough particle size, typically ~~a few ??? to~~ a few microns in diameter. The charging agents may be added at this time. Optionally, more suspending fluid may be added.

Please replace the paragraph bridging pages 27 and 28 with the following paragraph:

Useful organic solvents include, but are not limited to, epoxides, such as, for example, decane epoxide and dodecane epoxide; vinyl ethers, such as, for example, cyclohexyl vinyl ether and Decave[®] (International Flavors & Fragrances, Inc., New York, NY); and aromatic hydrocarbons, such as, for example, toluene and naphthalene. Useful halogenated organic solvents include, but are not limited to, tetrafluorodibromoethylene, tetrachloroethylene, trifluorochloroethylene, 1,2,4-trichlorobenzene, carbon tetrachloride. These materials have high densities. Useful hydrocarbons include, but are not limited to, dodecane, tetradecane, the aliphatic hydrocarbons in the Isopar[®] series (Exxon, Houston, TX), Norpar[®] (series of normal paraffinic liquids), Shell-Sol[®] (Shell, Houston, TX), and Sol-Trol[®] (Shell), naphtha, and other petroleum solvents. These materials usually have low densities. Useful examples of silicone oils

include, but are not limited to, octamethyl cyclosiloxane and higher molecular weight cyclic siloxanes, poly (methyl phenyl siloxane), hexamethyldisiloxane, and polydimethylsiloxane. These materials usually have low densities. Useful low molecular weight halogen-containing polymers include, but are not limited to, poly(chlorotrifluoroethylene) polymer (Halogenated hydrocarbon Inc., River Edge, NJ), Galden[®] (a perfluorinated ether from Ausimont, Morristown, NJ), or Krytox[®] from ~~Dupont~~ Dupont du Pont (Wilmington, DE). In a preferred embodiment, the suspending fluid is a poly(chlorotrifluoroethylene) polymer. In a particularly preferred embodiment, this polymer has a degree of polymerization from about 2 to about 10. Many of the above materials are available in a range of viscosities, densities, and boiling points.

Please replace the paragraph on page 30, lines 4-17 with the following paragraph:

Charge ~~adjuvants~~ adjuvants may also be added. These materials increase the effectiveness of the charge control agents or charge directors. The charge ~~adjuvant~~ adjuvant may be a polyhydroxy compound or an aminoalcohol compound, which are preferably soluble in the suspending fluid in an amount of at least 2% by weight. Examples of polyhydroxy compounds which contain at least two hydroxyl groups include, but are not limited to, ethylene glycol, 2,4,7,9-tetramethyl-~~decy~~decyne-4,7- diol, poly (propylene glycol), pentaethylene glycol, tripropylene glycol, triethylene glycol, glycerol, pentaerythritol, ~~glycerol tri-12 hydroxystearate~~ glycerol tris(12-hydroxystearate), propylene glycerol monohydroxystearate, and ethylene glycol ~~monohydroxystearate~~ monohydroxystearate. Examples of aminoalcohol compounds which contain at least one alcohol function and one amine function in the same molecule include, but are not limited to, triisopropanolamine, triethanolamine, ethanolamine, ~~3-amino-1-propanol~~ 3-amino-1-propanol, o-aminophenol, 5-amino-1-pentanol, and ~~tetra(2-hydroxyethyl)~~ tetrakis(2-hydroxyethyl)ethylene-diamine. The charge ~~adjuvant~~ adjuvant is preferably present in the suspending fluid in an amount of about 1 to about 100 mg/g of the particle mass, and more preferably about 50 to about 200 mg/g.

Please replace the paragraph on page 30, lines 18-25 with the following paragraph:

The surface of the particle may also be chemically modified to aid dispersion, to improve surface charge, and to improve the stability of the dispersion, for example. Surface modifiers include organic siloxanes, organohalogen silanes and other functional silane coupling agents (Dow Corning[®] Z-6070, Z-6124, and 3 additive, Midland, MI); organic titanates and zirconates (Tyzor[®] TOT, TBT, and TE Series, ~~Dupont~~ Dupont du Pont, Wilmington, DE); hydrophobing agents, such as long chain (C12 to C50) alkyl and alkyl benzene sulphonic acids, fatty amines or diamines and their salts or quarternary derivatives; and amphipathic polymers which can be covalently bonded to the particle surface.

Please replace the paragraph on page 31, lines 3-25 with the following paragraph:

Different non-limiting classes of charge control agents which are useful include organic sulfates or sulfonates, metal soaps, block or comb copolymers, organic amides, organic zwitterions, and organic phosphates and phosphonates. Useful organic sulfates and sulfonates include, but are not limited to, ~~bis(2-ethylhexyl)-sodium~~ bis(2-ethylhexyl) sulfosuccinate, calcium dodecyl benzene sulfonate, calcium petroleum sulfonate, neutral or basic barium dinonylnaphthalene sulfonate, neutral or basic calcium dinonylnaphthalene sulfonate, dodecylbenzenesulfonic acid sodium salt, and ammonium lauryl sulphate. Useful metal soaps include, but are not limited to, basic or neutral barium petronate, calcium petronate, Co-, Ca-, Cu-, Mn-, Ni-, Zn-, and Fe- salts of naphthenic acid, Ba-, Al-, Zn-, Cu-, Pb-, and Fe- salts of stearic acid, divalent and trivalent metal carboxylates, such as aluminum tristearate, aluminum ~~octanoate~~octanoate, lithium heptanoate, iron stearate, iron distearate, barium stearate, chromium stearate, magnesium ~~octanoate~~octanoate, calcium stearate, iron naphthenate, and zinc naphthenate, Mn- and Zn- heptanoate, and Ba-, Al-, Co-, Mn-, and Zn- ~~octanoate~~octanoate. Useful block or comb copolymers include, but are not limited to, AB diblock copolymers of (A) polymers of 2-(~~N,N~~)dimethylaminoethyl-2-(~~N,N~~)dimethylaminoethyl methacrylate quaternized with methyl-p-toluenesulfonate and (B) poly-2-ethylhexyl methacrylate, and comb graft copolymers with oil soluble tails of poly (12-hydroxystearic acid) and having a molecular weight of about 1800, pendant on an oil-soluble anchor group of poly (methyl methacrylate-methacrylic acid). Useful organic amides include, but are not limited to, polyisobutylene succinimides such as OLOA 1200, and N-vinyl pyrrolidone polymers. Useful organic zwitterions include, but are not limited to, lecithin. Useful organic phosphates and phosphonates include, but are not limited to, the sodium salts of phosphated mono- and di-glycerides with saturated and unsaturated acid substituents.

Please replace the paragraph on page 36, lines 1-15 with the following paragraph:

Surface tension modifiers can be added to adjust the air/ink interfacial tension. Polysiloxanes are typically used in such an application to improve surface levelling while minimizing other defects within the coating. Surface tension modifiers include, but are not limited to, fluorinated surfactants, such as, for example, the Zonyl[®] series from ~~DuPont-du Pont~~ (Wilmington, DE), the Fluorod[®] series from 3M (St. Paul, MN), and the fluoroakyl series from Autochem (Glen Rock, NJ); siloxanes, such as, for example, Silwet[®] from Union Carbide (Danbury, CT); and polyethoxy and polypropoxy alcohols. Antifoams, such as silicone and silicone-free polymeric materials, may be added to enhance the movement of air from within the ink to the surface and to facilitate the rupture of bubbles at the coating surface. Other useful antifoams include, but are not limited to, glyceryl esters, polyhydric alcohols, compounded antifoams, such as oil solutions of alkyl benzenes, natural fats, fatty acids, and metallic soaps, and silicone antifoaming agents made from the combination of dimethyl siloxane

polymers and silica. Stabilizers such as ~~uv~~UV-absorbers and antioxidants may also be added to improve the lifetime of the ink.

Please replace the paragraph on page 36, lines 16-18 with the following paragraph:

Other additives to control properties like coating viscosity and foaming can also be used in the coating fluid. Stabilizers (~~uv~~UV-absorbers, antioxidants) and other additives which could prove useful in practical materials.

Please replace the paragraph on page 36, lines 25-27 with the following paragraph:

Among the water-soluble polymers are the various polysaccharides, the polyvinyl alcohols, ~~N-methyl Pyrrolidone~~ N-methylpyrrolidone, N-vinyl pyrrolidone N-vinylpyrrolidone, the various Carbowax[®] species (Union Carbide, Danbury, CT), and poly-2-hydroxyethylacrylate.

Please replace the paragraph on page 39, lines 1-10 with the following paragraph:

To a 1L flask is added 0.5 g of Oil Blue N (Aldrich, Milwaukee, WI), 0.5 g of Sudan Red 7B (Aldrich), 417.25 g of Halogenated hydrocarbon Oil 0.8 (Halogenated hydrocarbon Products Corp., River Edge, NJ), and 73.67 g of Isopar-G[®] (Exxon, Houston, TX). The mixture is stirred at 60°C for six hours and is then cooled to room temperature. 50.13 g of the resulting solution is placed in a 50 mL polypropylene centrifuge tube, to which is added 1.8 g of titanium dioxide (TiO₂) (~~DuPont~~ du Pont, Wilmington, DE), 0.78 g of a 10% solution of OLOA 1200 (Chevron, Somerset, NJ), in Halogenated hydrocarbon Oil 0.8, and 0.15 g of Span 85 (Aldrich). This mixture is then sonicated for five minutes at power 9 in an Aquasonic Model 75D sonicator (VWR, Westchester, PA) at 30°C.